

REMARKS

In the Action, claims 1-3 and 5-9 are rejected. In response, claim 1 is amended to include the subject matter of claim 7, and claim 7 is cancelled. New claim 10 is added to depend from claim 8 to recite the step of continuously recycling the recovered unreacted (meth)acrylic acid. The pending claims in this application are claims 1-3, 5, 6, and 8-10 with claim 1 being the sole independent claim.

In view of these amendments and the following comments, reconsideration and allowance are requested.

Rejection under 35 U.S.C. § 103(a)

In the Action, the claims are rejected under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 6,414,182 to Shingai et al. The rejection is based on the position that Shingai et al. discloses each of the claimed steps including recycling of the unreacted materials to the reaction vessel. As recognized in the Action, Shingai et al. does not disclose distilling the resulting reaction mixture to recover unreacted (meth)acrylic acid and then recycling the recovered (meth)acrylic acid to the reaction vessel. Shingai et al. merely discloses a distillation step for purifying the final product.

Claim 1 is amended to include the subject matter of claim 7 and now recites that the concentration of the (meth)acrylic acid in the reaction liquid is in the range of 0.1 to 20 weight%. Shingai et al. does not disclose or suggest the reaction mixture including (meth)acrylic acid in the claimed concentration with recovering (meth)acrylic acid by distillation and recycling. As disclosed on page 14 of the specification, the concentration of the (meth)acrylic acid provides advantages that are not recognized in Shingai et al. For example, a (meth)acrylic acid concentration higher than 20 weight% in the reaction liquid

results in a reaction product that cannot be readily distilled to recover effective amounts of the unreacted (meth)acrylic acid. In particular, as noted on page 14, a (meth)acrylic acid concentration higher than 20 weight% requires a large number of plates in the rectifying column to carry out an effective distillation and recovery of the (meth)acrylic acid. Furthermore, a (meth)acrylic acid concentration below 0.1 weight% in the reaction liquid results in byproducts such as the diester and alkylene glycol mono(meth)acrylate, thereby reducing the effective yield and increasing the impurity content of the reaction product. Thus, the essential feature of the present invention is that unreacted (meth)acrylic acid is recovered by distillation. The present invention as claimed recites the condition, such as an amount of unreacted (meth)acrylic acid and an operational pressure.

Shingai et al. does not disclose or suggest the claimed concentration of the (meth)acrylic acid in the reaction liquid. Since Shingai et al. does not disclose the step of distilling the reaction product to recover unreacted (meth)acrylic acid, Shingai et al. provides no motivation or incentive to maintain the (meth)acrylic acid concentration within the claimed range.

Shingai et al. does not disclose or suggest the claimed process. The passages referred to in the Action disclose generally that unreacted reactants can be recovered from the reaction mixture. However, there is no specific teaching of how the unreacted reactants and particularly the unreacted (meth)acrylic acid are recovered. As recognized in the Action, Shingai et al. discloses a first step of separating the unreacted (meth)acrylic acid by conventional means and a subsequent second step of distilling the reaction mixture to purify the resulting hydroxyalkyl (meth)acrylate. Thus, Shingai et al. only discloses that unreacted (meth)acrylic acid is recovered by some kind of process. Shingai et al. does not disclose that unreacted (meth)acrylic acid is recovered by distillation. Thus, it is clear that Shingai et al.

distinguishes the process steps between the recovery of unreacted reactants and the purifying step by distillation. The Action suggests that it would be obvious to one of ordinary skill in the art to distill the reaction mixture to recover the unreacted (meth)acrylic acid. However, this suggestion is expressly contrary to the teachings of Shingai et al.

Shingai et al clearly does not recognize and does not suggest distilling any reaction mixture to recover the unreacted (meth)acrylic acid. Shingai et al effectively teaches away from the claimed invention.

More importantly, Shingai et al. only discloses the distillation step as a purifying step for the hydroxyalkyl (meth)acrylate to obtain pure hydroxyalkyl (meth)acrylate and not to recover unreacted (meth)acrylic acid for recycling to the reaction vessel. The purification step by distillation is clearly intended to remove impurities and byproducts that adulterate the resulting hydroxyalkyl (meth)acrylate. Accordingly, Shingai et al. provides no motivation or incentive to recycle the unreacted (meth)acrylic acid recovered by the distillation step.

Shingai et al. does not disclose a specific means to recover the unreacted (meth)acrylic acid. It is not obvious to one of ordinary skill in the art to recover the unreacted (meth)acrylic acid by distillation and to provide a reaction liquid having the recited amount of (meth)acrylic acid. Shingai et al. provides no motivation or incentive to one of ordinary skill in the art to distill the reaction mixture to recover the unreacted (meth)acrylic acid. Shingai et al. expressly distinguishes between the selective (meth)acrylic acid recovery step by conventional stripping and the subsequent purification step to remove the impurities and byproducts from the resulting hydroxyalkyl (meth)acrylate.

Shingai et al. does not disclose or suggest that unreacted (meth)acrylic acid can be recovered by distillation or that the resulting distillate can be recycled to the reaction apparatus. The distillates disclosed in Shingai et al. are obtained after the (meth)acrylic acid

has been removed by the conventional means. Accordingly, Shingai et al. does not disclose or suggest a distillate containing unreacted (meth)acrylic acid and does not disclose recycling the distillate to the reaction apparatus. As disclosed on page 2 of the specification, the (meth)acrylic acid has a strong affinity for hydroxyalkyl (meth)acrylate. The low relative volatility of the (meth)acrylic acid renders the recovery of the (meth)acrylic acid by distillation difficult to carry out. The process of Shingai et al. provides no suggestion that (meth)acrylic acid can be effectively recovered by distillation. The invention is directed to the discovery that the resulting reaction liquid containing unreacted (meth)acrylic acid, unreacted alkylene oxide and the resulting hydroxyalkyl (meth)acrylate can be distilled to recover unreacted (meth)acrylic acid and that the recovered (meth)acrylic acid can be recycled to the reaction vessel.

The passages referred to in the Action relates to conventional processes for removing unreacted residues of raw materials. These conventional practices for recovering unreacted materials and particularly unreacted (meth)acrylic acid do not use distillation. Conventional processes reserve the distillation process for removing impurities in the final purification step to obtain a purified hydroxyalkyl (meth)acrylate. Thus, Shingai et al. discloses that the unreacted (meth)acrylic acid may be removed prior to the distillation step.

For the reasons discussed above, it is not obvious to one of ordinary skill in the art to distill the reaction liquid containing unreacted (meth)acrylic acid, unreacted alkylene oxide and the resulting hydroxyalkyl (meth)acrylate to recover the unreacted (meth)acrylic acid and thereafter recycle the unreacted (meth)acrylic acid to the reaction vessel as claimed. Shingai et al. does not disclose or suggest distilling the reaction liquid at a pressure of 0.1 to 40 hPa to recover the unreacted (meth)acrylic acid. Since conventional methods do not recover unreacted (meth)acrylic acid by distillation, and in view of the low volatility of (meth)acrylic

acid, the claimed pressure during the distillation of the reaction mixture is not obvious to one of ordinary skill in the art. The importance of the operating pressure is shown in Comparative Example 1 and Comparative Example 2 of the specification, and is disclosed on page 11, line 13 to page 12, line 12. Distillation of the reaction mixture can cause clogging of the distillation column by the formation of a polymerized product when the pressure is above the claimed range. Furthermore, uncondensed vapor can form in the top of the condenser which can be difficult to recover and condensate can occur when the operating pressure is below the claimed range. Thus, in view of the properties of (meth)acrylic acid, the claimed operating pressure is not obvious over Shingai et al.

In view of the above, claim 1 is allowable over Shingai et al. The claims depending from claim 1 are also allowable for reciting additional steps of the invention which in combination of the process steps of claim 1 are not disclosed or suggested in Shingai et al. Claim 2 recites recovering unreacted alkylene oxide together with the unreacted (meth)acrylic acid by distillation, and thereafter recycling the recovered unreacted materials. As discussed above, Shingai et al. provides no suggestion of distilling the reaction mixture to recover the unreacted materials. Shingai et al. discloses only recovering reactants by processes that are distinct and distinguishable from the purification step by distillation. Accordingly, claim 2 is not obvious over Shingai et al. Claim 3 depends from claim 1 to recite a first step of recovering unreacted alkylene oxide from the reaction liquid, and thereafter recovering unreacted (meth)acrylic acid by distillation in a second separate step. Shingai et al. clearly fails to disclose or suggest recovering unreacted alkylene oxide in the first step, and thereafter distilling the reaction mixture to recover the unreacted (meth)acrylic acid. Accordingly, claim 3 is not obvious over Shingai et al.


Shingai et al. does not disclose carrying out the distillation step with a plate column and/or packed column as in claim 5, or the use of polymerization inhibitors during the distillation step as in claim 6, in combination with the process steps of claim 1.

Claim 8 recites the steps of recovering the unreacted (meth)acrylic acid by distillation, and thereafter purifying the resulting reaction liquid containing the crude hydroxyalkyl (meth)acrylate. Shingai et al. clearly fails to disclose or suggest these steps. In contrast, Shingai et al. specifically discloses a first step of recovering the unreacted reactants and thereafter purifying the hydroxyalkyl (meth)acrylate by distillation. Shingai et al. provides no suggestion of a subsequent purification step after the distillation step as in claim 8. Claim 9 depends from claim 8 to recite that the second purifying step is a second distillation step. Shingai et al. does not disclose or suggest a first distillation step to recover the unreacted (meth)acrylic acid and a second distillation step to purify the resulting reaction mixture. Accordingly, claims 8 and 9 are not obvious over Shingai et al.

Claim 10 depends from claim 1 to recite the step of continuously recycling the recovered unreacted (meth)acrylic acid from the distillation step through the reaction apparatus as a raw material. For the reasons discussed above, Shingai et al. does not disclose distilling the reaction mixture to recover unreacted (meth)acrylic acid, and thus, does not disclose continuously recycling unreacted (meth)acrylic acid from the distillation step. Accordingly, claim 10 is not obvious over Shingai et al.

In view of these amendments and the above comments, claims 1-3, 5, 6 and 8-10 are allowable over the art of record. Reconsideration and allowance of the claims are requested.

Respectfully submitted,



Garrett V. Davis
Reg. No. 32,023

Roylance, Abrams, Berdo & Goodman, L.L.P.
1300 19th Street, N.W., Suite 600
Washington, D.C. 20036-1649
(202) 659-9076

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